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Interactions Between Domestic and Export Markets for Softwood Lumber and Plywood: Tests of Six Hypotheses

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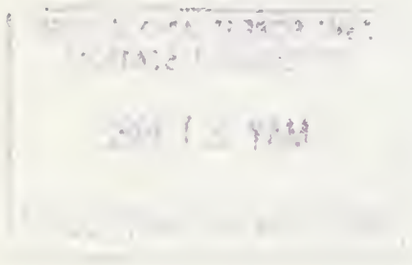

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Abstract

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Price formation in export markets and available data on export and domestic markets are discussed. The results of tests of several hypotheses about interactions between domestic and export markets are presented and interpreted from the standpoints of trade promotion and trade policy.

Keywords: Markets (external), markets (internal), market prices, trade policy, import/export (forest products), softwoods, plywood.

Summary

The objective of this report was to identify patterns of interactions between domestic and export markets in terms of volume and price. A conceptual model of trade in terms of excess supply and excess demand served as a basis for the analysis. The model was applied to analysis of the interaction of domestic production and prices and the volume and price of exports for softwood lumber and softwood plywood using quarterly data for the period, 1965-79. The focus of the analysis was to interpret these interactions from the standpoint of promotion of exports and trade policy that has the intent of making exports responsive to domestic market conditions.

Exports of softwood lumber were classified according to rough and dressed southern pine and by all other species in an attempt to account for possible differences in the characteristics of interactions of markets.

Results of the analysis suggest that prices in the export market have a positive, significant relationship to prices in the domestic market: The same set of variables that influence prices in one market influence prices in the other market or different sets of variables influence the two markets and are themselves related.

The results of tests of hypotheses about the behavior of prices and volumes in the two markets suggests that shifts in excess supply through shifts in the product mix of exports have had a major influence on the movements of the prices and volumes of exports of dressed softwood lumber and softwood plywood. For rough softwood lumber, results of the analysis suggest that shifts in excess demand have been especially important in determining the volume and price of exports.

Efforts to promote the export of U.S. softwood lumber and plywood to date have generally concentrated on attempts to shift excess demand for lumber and plywood to the sizes and grades consumed in the United States. If promotion efforts are successful over time, shifts in excess supply may increase in importance as sources of movements in the price and quantity of total exports.

If one accepts the view that manipulation of domestic demand for the purposes of promoting exports is generally unacceptable in the United States, then excess supply can be affected only through shifts in domestic supply.

Efforts to make the volume and price of exports responsive to domestic market conditions generally have the intent of relieving the pressure of exports on domestic prices when these prices are high. If the manipulation of domestic demand is dismissed as a viable option, efforts to relieve the pressure of exports on domestic prices are limited to increases (shifts) in domestic supply and/or decreases (shifts) in excess demand.

The results of the study suggest that shifts in supply and/or demand in one market are reflected quickly in the other market. From the standpoint of promotion of exports, this responsiveness to markets may contribute to the impression of U.S. producers being in and out of the export market, depending on domestic market conditions. The linkages of domestic and export markets also suggest that trade policy, to be effective in making exports responsive to domestic market conditions, must anticipate rather than respond to market interactions.

Introduction

The behavior of prices and volumes in export markets in relation to domestic markets is of interest for:

1. Formulation of trade policy particularly in developing a policy to reduce exports during times of high domestic prices and increase exports during times of low domestic prices.

2. Development and promotion of export sales. Over the past several years, there has been renewed interest in expansion of U.S. export of timber products.

The objective of this report is to identify patterns of interactions between domestic and export markets in terms of volume and price.

The pattern and causes of movements in prices and volumes in U.S. domestic markets for timber products have been the subject of numerous studies. A review of the literature is available in Adams and Haynes (1980). Analysis of the behavior of prices and volumes in U.S. export markets for timber products has been limited. Identification of patterns of market interactions between domestic and export markets is a first step in evaluating alternative trade and promotion policies. Much of the interest in export sales from the standpoint of trade policy and export promotion has been shown for softwood construction materials. The analyses in this report are limited to softwood lumber and softwood plywood.

The Hypotheses

The analyses in this report test the following hypotheses:

1. There is a positive relationship between price in the export market and price in the domestic market.

2. There is a positive relationship between price in the export market and the volume of exports.

3. There is a positive relationship between the volume of exports and the ratio of export to domestic prices.

4. There is a positive relationship between the volume of exports and the volume of domestic production.

5. There is a positive relationship between production in the United States and price in the export market.

6. There is a positive relationship between price in the domestic market and the volume of exports.

Patterns of market interactions indicated by tests of these hypotheses are interpreted for their implications for trade policy and promotion of exports after presentation of results and conclusions.

A Model of Trade

Markets cannot be modeled in total detail: Many variables are interacting at the same time and the influence of any one variable may be masked by the influence of other variables. Traditionally, analysts have attempted to abstract from some of the complexity of interactions in markets. The purpose has been to identify principles that underlie the behavior of markets under specified assumptions. The theory of price formation in export markets is presented in most texts on trade theory, for example, Kreinin (1971). This theory provides the conceptual framework for interpretating the tests of the hypotheses examined in this study. Key concepts in the theory are excess supply and excess demand.

Excess supply refers to the volume of product that producers in an exporting country are willing to sell in foreign markets at various prices. Excess demand refers to the volume of product that an importing country is willing to purchase from foreign producers at various prices.

Excess supply is determined by total supply and domestic demand in exporting countries. Excess demand is determined by total domestic supply and total demand in importing countries. The concept of excess supply and excess demand determining prices in the export market is illustrated in figure 1.

At prices above P_{1E} in the exporting country, supply exceeds demand. At prices below P_{1I} in the importing country, demand exceeds supply. The prices P_{1E} and P_{1I} would be the prices that would exist in the exporting and importing country, respectively, in the absence of trade. For trade to take place in the

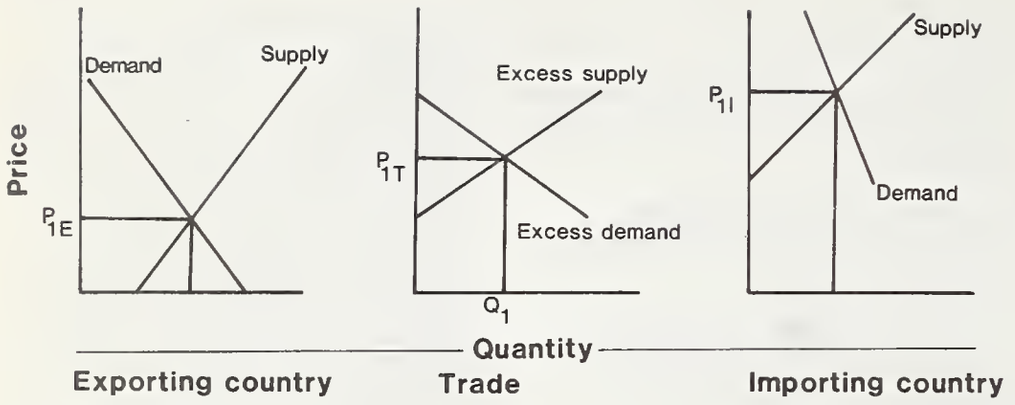

Figure 1.—Conceptual model of trade between two countries.

situation depicted in figure 1, P_{1I} must be greater than P_{1E}. If supply is subtracted from demand at prices lower than P_{1I} in the importing country, the demand for imports results. The "excess demand schedule" is equal to zero at price, P_{1I}. If demand is subtracted from supply at prices greater than P_{1E} in the exporting country, the export supply results. This "excess supply schedule" is equal to zero at price P_{1E}. The volume of exports is determined by the intersection of the excess supply and excess demand schedules. In figure 1, the volume of exports is equal to Q_1, at price P_{1T}. After trade occurs, the price of the commodity is equal to P_{1T} in both the exporting country and the importing country. Trade has the effect of raising prices in the exporting country and lowering prices in the importing country.

Changes in prices in the export market are caused by shifts in excess supply or shifts in excess demand, or by shifts in both at the same time. Shifts in excess supply schedule are caused by shifts in supply or demand in the exporting country. Variables that would cause demand to shift in the exporting country include population, income, housing starts, and consumer preferences. For example, an increase in housing starts would cause demand in the exporting country in figure 1 to shift upward and to the right. This would cause the excess supply schedule to shift upward and to the left. Price would increase in the exporting country. Through trade, price would also increase in the importing country.

Variables that would cause supply to shift in the exporting country include the cost of land and timber, the cost of labor, the cost of capital, and the type of processing equipment used. For example, an increase in the cost of timber would cause supply in the exporting country in figure 1 to shift upward and to the left. This would cause the excess supply schedule to shift upward and to the left. Price would increase in both the exporting and importing countries. Total production would decline in the exporting country and the volume exported would decline.

Shifts in the excess demand schedule are caused by shifts in supply or demand in the importing country. For example, an increase in housing starts in the importing country in figure 1 would cause demand to shift upward and to the right. This would cause the excess demand schedule to shift upward and to the right. Price would increase in both the importing and exporting countries and the volume of trade would increase. An increase in the cost of timber in the importing country would cause the supply schedule in the importing country to shift upward and to the left. The excess demand schedule would shift upward and to the right. The price of the commodity would increase as would the volume of imports.

Shifts in the price and volume of exports over time are determined by the interaction of shifts in supply and demand in the importing and exporting countries. The price and quantity of exports thus show the end result of these interactions. If the price and quantity of exports are the only data available over time, it is not possible to determine what caused prices and exports to change over time. For

example, in figure 2A, the price and quantity data could indicate that the excess supply schedule has remained stable over time and that all changes in price and export volume are attributable to shifts in the excess demand schedule. Alternatively, however, both the excess supply and excess demand schedules may have shifted over time, resulting in the pattern of prices and exports shown in figure 2A. Similarly in figure 2B, changes in prices and exports may be caused only by shifts in the excess supply schedule; or they may be caused by shifts in both the excess demand and excess supply schedules. In figure 2C, there is no apparent pattern to shifts in either the excess supply or excess demand schedule.

Trade policies that have the objective of making exports responsive to domestic market conditions generally must operate through tariffs and quotas that influence the excess supply schedule. Alternatively, the exporting country may try to implement policies that would increase domestic supplies during times of high prices, thereby making more of the commodity available to both domestic and export markets. Finally, the exporting country may somehow convince the importing country to implement policies designed to make their demands for imports responsive to market conditions in the exporting country.

Figure 2. — Examples of patterns of price and volume in an export market. **A.** Possible shifts in excess demand; **B.** Possible shifts in excess supply; **C.** No apparent pattern in shifts in excess supply and excess demand.

Efforts to promote exports must work through shifts in the excess supply schedule or shifts in the excess demand schedule. These efforts may take the form of subsidies or other incentives for exports and programs designed to point out market opportunities to producers in the exporting country. Attempts may be made to increase domestic supply so as to make more of the commodity available to both the domestic and export markets. Alternatively, the exporting country may shift domestic demand through taxes and other disincentives to consumption, thereby making more output available for the export market. Finally, the exporting country may somehow shift the excess demand schedule for the commodity in the importing country through promotion of the products of the exporting country and through reductions in tariff and nontariff trade barriers.

In this report, the United States is considered to be the exporting country as in figure 1. Exports from the United States are not analyzed by country of destination. The rest of the world is treated as the importing country. Product categories considered in the analyses are assumed to be homogeneous. For example, exported plywood is assumed to be identical in size and grade to plywood that is consumed domestically. Descriptions of models of trade that consider more than two countries, more than one product, and nonhomogeneous products are available in other sources such as Kreinin (1971).

Methods

Data

Specifications and tests of the hypotheses were determined in part by available data. The data sources for U.S. exports of all commodities originate with individual exporters who submit Export Declaration Forms to the U.S. Treasury Department. These forms provide information on the type of commodity exported and its volume, price, and country of destination. The U.S. Department of Treasury provides this information to the U.S. Department of Commerce which compiles and publishes the data.

The various categories of softwood lumber and softwood plywood as compiled in reports by the Department of Commerce are discussed in appendix A. The data provide a breakdown of exports by species for softwood lumber and less detail by species for softwood plywood. The detail on softwood lumber extends to categorization by rough and dressed or worked. The detail provided by these categories is in general not sufficient to relate export volumes and prices to specific end uses in the importing countries. For example, a 2″ x 4″ by 8′ piece of lumber is a different type of product than a 12″ by 12″ by 30′ timber. Nor do the available data on exports have any detail on the quality or grade of exports of either softwood lumber or softwood plywood.

Exports from Alaska have only an indirect effect on the volume and price of exports from the lower 48 States. As a result, exports from Alaska have not been given much weight in programs to expand U.S. exports of timber products nor have they received much weight in the formulation of policies to link export sales to conditions in domestic markets. In 1979, Alaska exported a total of 228 million board feet of lumber, almost all to Japan. This volume amounted to about 16 percent of total U.S. foreign sales of softwood lumber.

The data base for tests of the hypotheses consisted of quarterly data for the period, 1965-79. Especially during the 1970's, major movements in prices, production, and consumption of timber products have occurred within the period of a year. Annual data would tend to mask these types of changes.

For exports of softwood lumber and softwood plywood, U.S. Department of Commerce data for volume and value were aggregated into the following categories:

1. Rough lumber, except rough southern pine

2. Rough southern pine lumber

3. Dressed lumber, except dressed southern pine

4. Dressed southern pine lumber

5. Softwood plywood.

The distinction between rough and dressed lumber was made on the rationale that rough lumber probably consists of large timbers and other specialty items. These items may bear a different relationship between domestic and export markets than is the case for dressed lumber which is likely to consist of dimension lumber of the sizes and grades consumed in the U.S. domestic market.

Southern pine was differentiated from other softwood lumber primarily because export markets differ between the two categories. Southern pine export volume is concentrated in shipments to Central America and Western Europe. Except for shipments from Alaska, most of the softwood lumber exports other than southern pine originate in the West, primarily Washington and Oregon. Lumber of western species is shipped worldwide.

No data are available to differentiate end uses of the various categories of softwood plywood in the export market. All categories of softwood plywood were combined for the purposes of this analysis.

The volume and value data for the categories of exports used in the analysis are shown in table 1. In recent years, rough lumber except southern pine accounted for about 64 percent of total exports; rough southern pine, 8 percent; dressed lumber except southern pine, 25 percent; and dressed southern pine the remaining 3 percent. Exports from Alaska amount to almost 16 percent of total shipments. The generally higher prices for rough compared with dressed lumber indicate that the rough lumber category probably includes specialty items such as clear timbers that command premium prices. The average value of each category of exports has generally been increasing over time, especially in the 1970's.

All data were tested for seasonality, and there were no significant seasonal patterns in any of the data series (see appendix B for details).

Data for domestic production and prices used in the analysis are shown in table 2. The data series were tested for seasonality and adjusted where significant seasonal patterns were found (see appendix B for details). Significant seasonal patterns were found for all data series for production of softwood lumber. The original and seasonally adjusted data series are shown in table 2. The seasonally adjusted data series were used in the analyses that follow.

In recent years, the southern pine region has accounted for about 27 percent of U.S. production of softwood lumber and the Douglas-fir region, 28 percent. The States of Washington and Oregon together account for 49 percent of total U.S. exports of softwood lumber.

Total U.S. softwood plywood production increased rapidly during the 1960's and early 70's but has shown no growth trend in recent years. In the late 1970's, the States of Washington and Oregon accounted for 82 percent of U.S. exports of softwood plywood.

Procedure for Testing Hypotheses

In the analyses that follow, hypotheses of relationships between variables are tested using the linear relationship, $Y = A + Bx$, where Y is the dependent variable, A is a constant, B is the slope or regression coefficient, and x is the independent variable.

No attempt is made to identify causality in the relationships. The emphasis is on whether change in one variable is related to change in another. For example, in the case of the relationship between prices in the export and domestic markets, previous discussion has pointed out that prices in these markets are determined by the interactions of variables affecting supplies and demands in both markets. Without additional information on supply and demand conditions in the two markets, one cannot infer that prices in one market are determined by prices in the other: Prices are determined simultaneously.

In the analyses that follow, the standard F test was used to determine if the slope coefficient was significantly different from zero. This test of the slope coefficient is a test of the stated hypotheses.

In accepting or rejecting a hypothesis, the 5-percent level of significance is used. This means that the probability of obtaining a significant value of F when the two variables actually are completely uncorrelated is 5 percent.

All relationships were quantified using a data base for the 1965-79 period. These relationships were tested for autocorrelation according to the Durbin-Watson statistic. When autocorrelation was indicated, the relationship was respecified and estimated in terms of residuals.

Implications of the analysis for trade promotion programs and trade policies are discussed after presentation of the results of tests of the hypotheses.

Table 1—Volume and average value of U.S. exports of softwood lumber and softwood plywood and volume of softwood lumber exports from Alaska, 1965-79

Year and quarter	Softwood lumber										Softwood plywood		Softwood lumber, Alaska[1]
	Rough except southern pine		Rough southern pine		Dressed except southern pine		Dressed southern pine		Total				
	Volume[1]	Average value[2]	Volume[1]	Average value[2]	Volume[1]	Average value[2]	Volume[1]	Average value[2]	Volume[1]	Average value[2]	Volume[3]	Average value[4]	
1965:													
1st	138.8	114.56	13.0	149.81	17.9	100.53	6.4	129.69	176.1	280.78	6.8	135.16	34.2
2d	136.6	121.13	21.7	153.30	24.9	107.40	10.8	134.77	194	266.30	6.5	128.35	51.3
3d	168.1	121.03	16.2	153.23	33.3	110.34	7.8	125.12	225.4	226.11	9.3	123.04	51.3
4th	148.6	121.85	18.1	152.97	86.7	39.66	10.2	132.27	263.6	169.54	10.5	117.75	34.2
1966:													
1st	133.8	117.12	19.5	147.38	24.4	108.66	9.8	112.97	187.5	259.26	9.7	113.59	40.8
2d	188.7	119.64	17.8	153.14	39.7	108.54	8.2	123.52	254.4	198.48	10.6	123.86	61.2
3d	147.8	115.47	15.4	152.21	48.8	102.36	8.7	135.92	220.7	229.23	11.6	124.39	61.2
4th	141.9	118.96	12.5	161.76	48.2	104.12	9.0	134.14	211.6	245.23	15.8	106.41	40.8
1967:													
1st	140.7	113.51	14.4	154.89	32.4	110.06	7.5	131.14	195	261.33	20.6	101.60	18.8
2d	205.4	106.77	14.3	161.35	38.8	104.07	7.6	134.31	266.1	190.37	20.5	106.69	60.4
3d	187.7	102.31	10.3	159.22	47.5	110.95	8.6	134.38	254.1	199.43	22.0	106.14	62.9
4th	180.3	106.36	15.7	153.96	42.6	103.87	9.2	145.86	247.8	205.83	21.8	105.15	61.8
1968:													
1st	213.6	108.61	13.4	159.34	47.7	112.15	9.7	110.66	284.4	172.59	15.8	116.28	74.1
2d	197.2	124.45	14.5	162.75	44.2	118.12	8.4	154.15	264.3	211.70	16.5	142.46	54.4
3d	192.6	124.52	13.9	160.16	39.5	129.56	9.6	158.24	255.6	223.99	16.9	131.55	59.6
4th	189.2	131.84	15.0	124.94	38.6	124.72	11.2	175.96	254	219.46	14.7	137.43	57.6
1969:													
1st	149.4	137.99	7.1	158.60	34.2	146.21	4.4	183.33	195.1	320.90	13.5	162.95	45.7
2d	209.0	138.80	15.3	170.64	49.4	153.15	8.3	180.06	282	227.88	55.5	121.37	81.2
3d	195.1	160.25	11.9	166.63	48.8	128.76	7.8	177.71	263.6	240.26	80.0	111.37	76.9
4th	216.9	152.40	13.5	173.13	51.0	109.49	6.9	149.01	288.3	202.60	50.3	115.12	82.0
1970:													
1st	187.2	161.19	11.7	177.54	46.4	119.77	7.6	157.87	252.9	243.75	28.4	112.24	60.5
2d	270.5	137.25	19.6	182.60	39.8	127.31	5.3	166.44	335.2	183.03	31.4	102.64	86.2
3d	249.8	112.25	12.5	182.03	54.3	114.59	5.3	153.52	321.9	174.68	23.3	123.82	105.5
4th	155.7	176.86	13.0	181.23	61.1	113.68	5.0	153.53	234.8	266.30	30.7	129.55	63.4
1971:													
1st	167.6	153.35	10.9	193.14	45.1	125.94	5.0	164.77	228.6	278.72	26.5	119.62	43.9
2d	169.3	158.80	11.0	188.92	49.7	147.32	7.2	198.59	237.2	292.41	29.8	135.20	50.3
3d	145.8	124.85	13.2	146.78	42.9	152.01	7.7	218.02	209.6	306.09	7.8	142.72	73.7
4th	173.8	136.36	4.9	175.89	40.5	152.16	5.6	219.04	224.8	304.04	35.0	138.11	79.5
1972:													
1st	200.4	147.60	7.5	175.75	57.3	138.02	7.0	280.57	272.2	272.63	34.3	119.19	91.0
2d	215.5	178.53	9.8	185.11	61.6	180.86	6.8	274.50	293.7	278.82	56.2	145.25	69.4
3d	226.8	175.80	9.9	210.43	70.7	148.75	5.3	298.98	312.7	266.69	82.7	140.94	99.3
4th	205.3	181.85	15.4	251.98	59.2	176.41	3.6	366.15	283.5	344.41	50.3	162.82	80.5

1973:													
1st	374.0	191.88	12.4	233.47	84.0	172.50	3.7	328.93	474.1	195.47	76.9	149.83	93.9
2d	300.4	269.35	24.2	232.65	89.7	174.19	4.2	165.83	418.5	225.12	77.8	165.82	101.6
3d	379.2	269.23	24.6	219.87	82.1	180.26	4.3	269.57	490.2	191.52	97.0	164.16	121.4
4th	277.6	316.80	17.2	261.99	84.7	179.54	4.3	303.30	383.8	276.61	210.7	103.14	88.0
1974:													
1st	350.9	284.43	14.2	299.63	91.4	214.22	4.7	319.99	461.2	242.48	202.6	151.52	105.7
2d	372.5	259.65	15.1	271.73	87.0	222.62	8.8	310.91	483.4	220.29	146.2	163.42	108.3
3d	236.1	271.46	13.1	268.49	61.1	240.79	6.5	275.51	316.8	333.43	111.5	154.24	64.2
4th	210.3	225.36	11.6	243.40	63.7	210.00	6.0	281.83	291.6	329.43	89.2	141.07	84.2
1975:													
1st	218.8	236.17	5.7	254.0	69.6	206.88	5.1	246.79	299.2	315.50	83.1	144.03	80.4
2d	230.3	249.50	11.2	314.2	81.4	212.51	6.8	274.13	329.7	318.61	151.3	165.55	74.9
3d	308.7	266.22	11.6	316.66	86.7	224.59	7.2	270.26	414.2	260.17	276.9	163.35	101.9
4th	233.9	273.82	12.8	324.20	95.3	232.62	9.7	269.46	351.7	312.76	285.0	153.57	56.2
1976:													
1st	224.7	278.37	22.8	310.22	97.8	244.89	11.4	299.69	346.7	326.81	161.0	174.33	59.0
2d	277.1	310.02	25.4	362.79	93.7	259.70	9.4	339.55	405.5	313.70	271.1	175.55	69.2
3d	296.2	300.13	30.7	332.46	92.7	229.12	8.4	306.74	428.0	273.01	139.8	176.77	97.2
4th	275.6	324.72	28.1	343.88	87.5	285.60	15.8	323.90	407.0	314.04	154.4	197.20	64.7
1977:													
1st	275.2	300.59	29.7	359.65	86.3	295.65	9.5	349.73	400.7	325.85	103.9	186.95	59.4
2d	261.6	325.83	37.7	369.56	88.2	297.76	13.3	330.03	400.8	330.12	80.2	192.58	67.8
3d	217.3	304.34	31.6	392.28	74.8	286.11	14.6	379.21	338.3	402.63	53.4	212.90	64.0
4th	181.3	327.50	31.5	362.67	88.9	251.64	13.6	384.30	315.3	420.58	57.0	225.16	58.8
1978:													
1st	205.5	315.81	22.6	400.94	77.9	256.95	8.2	335.73	314.2	416.72	72.3	211.49	53.7
2d	245.2	336.58	28.7	421.92	106.9	264.02	8.2	309.93	389.0	342.53	103.1	204.86	61.0
3d	184.5	353.92	24.0	457.74	107.3	252.57	6.1	336.79	321.9	435.24	52.3	230.80	56.1
4th	213.6	386.73	31.0	452.72	99.4	317.59	11.4	397.42	355.4	437.37	69.9	240.69	67.0
1979:													
1st	268.4	418.46	42.3	347.77	86.4	335.79	9.0	384.76	406.1	366.09	108.6	232.23	80.7
2d	292.1	489.81	30.5	510.31	114.3	339.41	10.1	457.03	447.0	401.91	114.7	240.48	75.8
3d	283.3	506.30	31.4	573.88	116.3	341.39	12.4	465.10	443.4	425.48	96.2	260.53	64.2
4th	264.6	522.38	36.0	584.39	108.0	356.27	24.0	445.93	432.6	441.26	82.3	253.94	57.8

[1]In million board feet.
[2]In dollars per thousand board feet.
[3]In million square feet, 3/8-inch basis.
[4]In dollars per thousand square feet.

Source: Ruderman (1981) and U.S. Bureau of the Census (monthly).

Table 2—Wholesale price indexes (1967 = 100) for Douglas-fir lumber, southern pine lumber, all softwood lumber, and softwood plywood; production of softwood lumber in the southern pine region; U.S. production of softwood lumber other than in the southern pine region, and production of softwood plywood, 1965-79

Year and quarter	Wholesale price indexes				Production of softwood lumber (Million board feet)								Production of softwood plywood[1]
					Southern pine region		Douglas-fir region		Total except southern pine region		Total		
	Douglas-fir lumber	Southern pine lumber	All softwood lumber	Softwood plywood	Actual	Seasonally adjusted	Actual	Seasonally adjusted	Actual	Seasonally adjusted	Actual	Seasonally adjusted	
1965:													
1st	94.3	89.7	95.3	95.3	1,594	1,633	2,148	2,108	5,167	5,317	6,761	6,947	2,861
2d	92.0	89.9	96.2	96.2	1,650	1,595	2,256	2,159	5,662	5,384	7,312	6,981	3,072
3d	92.3	91.7	96.9	96.9	1,719	1,701	2,250	2,292	6,075	5,903	7,794	7,608	3,011
4th	91.0	94.0	97.6	97.6	1,665	1,700	2,259	2,367	5,627	5,939	7,292	7,636	3,239
1966:													
1st	93.7	96.2	99.0	99.0	1,633	1,673	2,304	2,261	5,643	5,806	7,276	7,477	3,317
2d	102.2	101.6	99.4	99.4	1,753	1,695	2,317	2,218	6,070	5,772	7,823	7,469	3,442
3d	97.5	102.5	100.5	100.5	1,655	1,637	2,004	2,041	5,631	5,472	7,286	7,112	3,137
4th	93.6	100.6	94.9	99.8	1,568	1,601	1,811	1,897	4,894	5,166	6,462	6,767	2,914
1967:													
1st	96.3	98.5	95.7	99.8	1,548	1,586	2,043	2,005	5,190	5,340	6,738	6,924	3,057
2d	98.2	98.9	98.2	99.6	1,613	1,560	2,120	2,029	5,543	5,271	7,156	6,832	3,147
3d	102.3	100.5	101.8	100.1	1,603	1,586	1,942	1,978	5,498	5,342	7,101	6,931	3,202
4th	103.5	102.4	103.8	100.2	1,651	1,686	1,941	2,033	5,228	5,518	6,879	7,204	3,299
1968:													
1st	110.7	106.8	110.1	101.5	1,652	1,693	2,203	2,162	5,492	5,651	7,144	7,341	3,476
2d	116.7	112.1	117.8	102.2	1,760	1,702	2,339	2,239	6,098	5,799	7,858	7,502	3,669
3d	124.6	115.7	123.4	102.6	1,774	1,755	2,152	2,192	5,993	5,823	7,767	7,581	3,702
4th	129.1	120.7	130.9	103.1	1,868	1,908	2,087	2,186	5,586	5,896	7,454	7,806	3,842
1969:													
1st	142.5	128.7	151.0	104.3	1,985	2,034	2,129	2,089	5,486	5,645	7,471	7,677	3,754
2d	144.4	136.8	147.7	106.0	2,018	1,951	2,181	2,088	5,729	5,448	7,747	7,396	3,775
3d	117.3	119.5	121.1	106.8	1,843	1,823	1,918	1,953	5,405	5,252	7,248	7,075	3,240
4th	116.5	115.8	117.7	107.9	1,799	1,837	1,990	2,085	5,216	5,505	7,015	7,346	3,499
1970:													
1st	110.2	115.0	113.6	109.5	1,672	1,913	1,712	1,877	5,023	5,169	6,695	6,880	3,359
2d	109.6	113.5	113.4	110.0	1,789	1,730	1,934	1,851	5,319	5,058	7,107	6,785	3,664
3d	108.9	114.1	113.6	110.7	1,765	1,746	1,862	1,896	5,288	5,138	7,053	6,884	3,826
4th	106.9	116.0	112.9	110.9	1,837	1,876	1,767	1,851	4,717	4,979	6,555	6,864	3,724
1971:													
1st	121.9	122.3	123.4	122.8	1,802	1,847	1,998	1,961	5,152	5,301	6,954	7,146	4,008
2d	136.9	130.8	138.0	121.6	1,995	1,929	2,112	2,022	5,619	5,343	7,614	7,269	4,200
3d	149.3	140.5	152.9	132.6	1,976	1,955	2,098	2,137	5,775	5,611	7,751	7,566	4,229
4th	142.5	141.6	149.4	131.9	1,961	2,003	2,075	2,174	5,464	5,767	7,425	7,775	4,276
1972:													
1st	151.1	145.5	157.6	145.7	2,020	2,070	2,275	2,233	5,713	5,879	7,733	7,946	4,632
2d	158.7	151.4	165.1	155.6	2,154	2,083	2,263	2,166	6,031	5,735	8,185	7,815	4,732
3d	166.5	153.3	172.1	160.8	2,124	2,101	2,297	2,339	5,934	5,766	8,078	7,885	4,595
4th	168.1	155.8	176.1	157.4	2,039	2,082	2,057	2,155	5,538	5,845	7,577	7,935	4,563

1973:													
1st	188.8	164.3	192.6	197.4	2,042	2,093	2,346	2,302	5,898	6,069	7,940	8,159	4,872
2d	217.0	187.6	225.2	228.1	2,010	1,943	2,363	2,262	6,256	5,949	8,266	7,892	4,900
3d	217.5	197.9	220.8	159.0	1,973	1,952	2,208	2,249	5,974	5,805	7,947	7,757	4,518
4th	215.1	201.8	218.6	191.6	1,870	1,910	2,157	2,260	5,627	5,939	7,497	7,851	4,486
1974:													
1st	217.5	196.5	220.6	191.4	1,910	1,957	2,094	2,055	5,518	5,678	7,428	7,633	4,247
2d	231.9	194.7	234.0	214.0	2,054	1,986	2,202	2,108	6,034	5,738	8,088	7,722	4,561
3d	217.6	178.8	210.9	178.2	1,730	1,712	1,894	1,929	5,334	5,183	7,064	6,895	4,212
4th	187.8	168.0	180.1	163.4	1,427	1,457	1,590	1,666	4,034	4,258	5,461	5,719	3,488
1975:													
1st	194.3	164.5	184.0	188.1	1,473	1,509	1,645	1,614	3,978	4,093	5,451	5,601	3,699
2d	220.8	181.9	206.3	212.7	1,759	1,701	1,883	1,802	5,130	4,878	6,889	6,577	4,139
3d	219.2	217.8	206.6	200.6	1,772	1,753	1,870	1,905	5,296	5,146	7,068	6,899	4,406
4th	213.7	176.7	205.5	200.9	1,786	1,824	1,736	1,819	4,844	5,113	6,630	6,943	4,384
1976:													
1st	239.7	203.1	234.6	240.2	1,842	1,888	2,073	2,035	5,380	5,536	7,222	7,421	4,764
2d	239.1	215.8	243.2	236.6	1,896	1,833	1,996	1,911	5,575	5,302	7,471	7,133	4,802
3d	256.6	222.5	251.2	245.9	2,169	2,146	1,998	2,035	5,722	5,560	7,891	7,702	4,816
4th	267.8	227.7	263.5	266.8	2,080	2,124	2,062	2,160	5,682	5,997	7,762	8,128	4,555
1977:													
1st	276.9	236.3	281.6	283.3	2,025	2,075	2,241	2,199	5,609	5,772	7,634	7,844	4,954
2d	278.2	245.4	285.5	276.2	2,115	2,045	2,229	2,134	5,747	5,465	7,862	7,506	4,978
3d	306.0	280.5	310.8	314.3	2,090	2,068	2,140	2,180	5,806	5,642	7,896	7,707	4,917
4th	297.6	286.7	312.1	308.2	1,968	2,010	2,186	2,290	5,536	5,872	7,531	7,886	4,828
1978:													
1st	312.9	295.9	331.6	323.1	1,958	2,007	2,370	2,326	5,646	5,810	7,604	7,814	5,030
2d	326.7	302.8	341.4	314.2	2,193	2,120	2,285	2,187	5,720	5,439	7,913	7,555	5,126
3d	353.3	305.9	348.4	328.5	2,090	2,068	2,023	2,060	5,535	5,378	7,625	7,443	4,803
4th	367.4	310.5	361.4	339.3	2,046	2,089	2,167	2,270	5,488	5,793	7,534	7,890	4,977
1979:													
1st	362.8	309.0	364.9	342.9	2,038	2,088	2,156	2,060	5,306	5,382	7,344	7,468	5,016
2d	380.6	316.4	380.4	316.4	2,007	2,941	2,185	2,035	5,641	5,286	7,648	7,224	5,146
3d	406.5	332.7	393.4	323.6	2,034	2,012	2,048	2,030	5,612	5,438	7,646	7,449	4,882
4th	383.9	337.9	380.5	307.3	1,859	1,899	2,038	2,077	5,247	5,521	7,106	7,425	4,690

[1]In million square feet, 3/8-inch basis.

Source: Unadjusted data from National Forest Products Association (1981). Seasonal adjustments discussed in Appendix B.

Results

Hypothesis 1: There is a positive relationship between the price in the export market and price in the domestic market.

The hypothesis was tested for the data series shown in table 3. All relationships were respecified and estimated in terms of a lag of one quarter; and for each index, 1967 = 100. The price indexes were not deflated by the U.S. wholesale price index for all commodities.

All relationships were significant and positive (table 3). Values of R^2 for all unlagged relationships exceeded .5; and for lagged relationships, they exceeded .43. According to the conceptual framework discussed previously, a positive relationship between the prices in the export and domestic markets could occur under any of the following conditions:

1. Domestic supply and excess demand assumed not to shift. An increase (shift) in demand in the domestic market would decrease (shift) excess supply in the export market. The increase in domestic demand would cause prices to increase in both markets.

2. Domestic demand and excess demand assumed not to shift. A decrease (shift) in domestic supply would have the effect of raising prices in the domestic market. The decrease in domestic supply also would decrease (shift) excess supply in the export market, leading to higher prices.

3. Domestic demand and supply assumed not to shift. An increase (shift) in excess demand in the export market would lead to higher prices in both markets.

Table 3—Results of tests of hypothesis 1, by price series

Price series	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Price of rough southern pine lumber in the export market and price of southern pine lumber in the domestic market:					
Domestic price not lagged	-1.528	0.951	0.8	227.8[1/]	1.94
Domestic price lagged	7.23	.898	.753	174[1/]	1.64
2. Price of dressed southern pine lumber in the export market and price of southern pine lumber in the domestic market:					
Domestic price not lagged	11.939	.813	.51	59.26[1/]	1.91
Domestic price lagged	25.32	.696	.431	43.10[1/]	1.75
3. Price of rough softwood lumber except rough southern pine in the export market and price of Douglas-fir lumber in the domestic market:					
Domestic price not lagged	0.969	6.795	.805	235.5[1/]	2.1
Domestic price lagged	7.136	1.058	.825	269[1/]	1.69
4. Price of dressed softwood lumber except dressed southern pine in the export market and price of Douglas-fir lumber in the domestic market:					
Domestic price not lagged	17.19	.754	.843	305.7[1/]	2.08
Domestic price lagged	23.781	.735	.821	262[1/]	1.68
5. Price of all softwood lumber in the export market and price of softwood lumber in the domestic market:					
Domestic price not lagged	12.052	.921	.787	211[1/]	1.64
Domestic price lagged	3.249	.9669	.741	163.2[1/]	2.1
6. Price of softwood plywood in the export and domestic markets:					
Domestic price not lagged	51.418	.443	.741	163.3[1/]	1.57
Domestic price lagged	57.578	.484	.894	480.9[1/]	1.59

[1/] Significant at 5-percent level.

4. A combination of shifts in domestic demand and supply and excess demand that leads to a pattern of a positive relationship in prices in the two markets.

A positive relationship between price changes in the two markets is not surprising in view of the conceptual framework for price formation discussed previously. If prices were not equal, domestic consumers would purchase products offered in the export market and foreign consumers would purchase products offered in the domestic market. Price series in the two markets were placed on an index basis with 1967 = 100. This has the effect of equalizing prices in the two markets. For example, the price in the two markets equals 100 for 1967 despite the existence of an actual price difference in that year. Since the price series are on an index basis, the regression coefficient, B, in each equation should be close to 1 if all of the assumptions of the conceptual model of price formation actually hold for the two markets.

The regression coefficient was significantly different from 1 at the 5-percent level[1] for category 2 in table 3 with the domestic price lagged one quarter and for categories 4 and 6 with domestic price unlagged or lagged. The regression coefficient for category 2 with domestic price unlagged was significantly different from 1 at the 10-percent level. There are no data available to document why prices in the two markets do not tend to equalize for the two categories of dressed lumber (categories 2 and 4 in table 3) and softwood plywood (category 6). A possible explanation is that the product mix for dressed lumber and softwood plywood in the export market changes when price changes in the domestic market. For example, U. S. producers may be less willing to produce specialty items for the export market when domestic markets are going through an up phase of the cycle in prices. When domestic markets turn down, U. S. producers may be more willing to produce items specifically for the export market. The product mix for rough softwood lumber may not tend to vary in the export market according to domestic market conditions. This explanation of the observed behavior of prices would support the idea that shifts in excess supply may be especially important in determining prices and volumes in export markets for dressed lumber and softwood plywood. The pattern of behavior of prices for rough softwood lumber does not offer insight into underlying shifts in excess supply and excess demand.

For all of the categories in table 3, correlation coefficients with domestic price unlagged were not significantly different from correlation coefficients with domestic price lagged[2]. This suggests that information on price movements in the two markets may be generally available: Exporters can follow domestic markets well and mills in the domestic market can follow export markets well.

Hypotheses 2: There is a positive relationship between price in the export market and the volume of exports.

The hypotheses was tested for the data series shown in table 4. All prices in the export market were converted to indexes (1967 = 100) and deflated by the U.S. wholesale price index for all commodities (1967 = 100) in order to reduce an upward trend in prices attributable in part to inflation. For each series of quantities and prices, the hypothesized relationship was respecified and quantified with a lag of one quarter in the price variable. This was done to see if exports respond to price changes with a lag of one quarter. A lag may exist because of characteristics of markets such as long-term contracts that would have volume and price specified for a quarter or more into the future.

[1] A T-test was applied to test the hypothesis that the regression coefficient was equal to 1 as per Snedecor and Cochran (1967).

[2] The hypothesis that the two correlation coefficients were drawn from the same population was tested by transforming the regression coefficients to Z′ values and testing the significance of differences in the Z′ values as per Snedecor and Cochran (1967) at the 5-percent level.

Table 4—Results of tests of hypothesis 2, by product category and price series

Product category and price series	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Quantity and price of dressed southern pine lumber:					
Price not lagged	1.351	3.511	0.041	2.46	1.796
Price lagged	3.489	-3.359	-.04	2.40	1.724
2. Quantity and price of dressed lumber except southern pine:					
Price not lagged	17.082	-31.477	-.177	12.27[1/]	2.139
Price lagged	12.142	28.345	.12	7.73[1/]	2.084
3. Quantity and price of rough southern pine:					
Price not lagged	.472	16.067	.109	6.96[1/]	1.551
Price lagged	4.366	7.249	.035	2.09	1.72
4. Quantity and price of rough lumber except southern pine:					
Price not lagged	33.534	137.045	.401	38.23[1/]	1.596
Price lagged	53.576	125.607	.447	46.07[1/]	1.221
5. Quantity of rough lumber, except exports from Alaska and southern pine and price of rough lumber except southern pine:					
Price not lagged	-5.274	114.673	.452	46.99[1/]	1.697
Price lagged	23.485	89.09	.309	25.44[1/]	1.856
6. Quantity of rough lumber, except exports from Alaska and price of rough lumber:					
Price not lagged	-91.42	259.118	.634	98.6[1/]	1.741
Price lagged	30.214	157.15	.33	28.02[1/]	1.709
7. Quantity and price of all softwood lumber:					
Price not lagged	-60.881	289.169	.605	87.42[1/]	1.882
Price lagged	55.568	184.57	.344	29.92[1/]	1.704
8. Quantity and price of softwood plywood:					
Price not lagged	59.249	-80.749	-.098	6.21[1/]	1.73
Price lagged	26.777	-8.911	-.001	.082	1.86

[1/]Significant at 5-percent level.

For rough lumber, there was a significant, positive relationship between the quantity exported and the price of lumber in the export market (categories 3, 4, 5, and 6 in table 4). With the exception of rough southern pine lumber, the relationships remained significant when price was lagged by one quarter with an effect generally to lessen the size of the correlation coefficient.

According to the model of trade discussed previously, a positive relationship between quantity and price in the export market could occur under any of the following conditions:

1. Domestic demand assumed not to shift. A decrease (shift) in domestic supply would increase price in the export market. Volume could increase only if excess demand increased (shifted).

2. Domestic supply assumed not to shift. An increase (shift) in domestic demand would increase price in the export market. Volume could increase only if excess demand increased (shifted).

3. Excess supply assumed not to shift. An increase (shift) in excess demand would increase price and volume in the export market.

4. A combination of shifts in excess supply and excess demand.

There was a significant, negative relationship between the price and quantity of dressed lumber except southern pine, indicating that shifts in excess supply are probably important in determining the volume of exports. When the price of this commodity was lagged one quarter, the relationship was still significant, but positive rather than negative.

There was no significant relationship between the quantity and price of dressed southern pine lumber in the export market.

There was a significant, negative relationship between the volume of exports of softwood plywood and the unlagged price of these exports. This suggests that shifts in excess supply have been important in determining the volume and price of these exports.

The findings of negative correlation between export volume and price for dressed lumber except southern pine and softwood plywood supports the findings in the test of hypothesis 1 in that shifts in excess supply have probably been important in determining prices in export markets for these products.

Correlation coefficients with price not lagged and with price lagged were significantly different for both categories 6 and 7 in table 4. An effect of lagging price by one quarter was to reduce correlation between price and volume. This suggests that a spot market with prices determined by current market conditions may be an important means of price formation of rough lumber.

Hypothesis 3: There is a positive relationship between the volume of exports and the ratio of export to domestic prices.

The hypothesis was tested for the relationships shown in table 5. For each series of quantities and price ratios, the hypothesized relationship was respecified and quantified with a lag of one quarter in the price ratio variable. Prices in the two markets were converted to indexes (1967 = 100).

The results of analysis of hypothesis 1 suggest that the ratio of export to domestic prices would not vary much with the exceptions of dressed lumber and softwood plywood. Except for these two categories, price changes in one market are reflected in similar price changes in the other market. The results of the test of hypothesis 3 are consistent with the results of the test of hypothesis 1. Significant relationships were found only for exports of dressed softwood lumber except southern pine and exports of softwood plywood with the ratio of prices lagged one quarter (table 5). In both cases, the relationships were negative, suggesting that shifts in excess supply were probably important contributors to determination of prices for these two product categories.

Table 5—Results of tests of hypothesis 3, by product category and price series

Product category and price series	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Quantity of exports of dressed southern pine lumber and the ratio of the price of these exports to the price of southern pine lumber in the U.S. domestic market:					
Price ratio not lagged	2.333	2.761	0.02	1.14	1.62
Price ratio lagged	1.694	3.642	.04	2.13	1.73
2. Quantity of exports of rough southern pine lumber and the ratio of the price of these exports to the price of southern pine lumber in the U.S. domestic market:					
Price ratio not lagged	3.441	4.302	.014	0.82	2.23
Price ratio lagged	2.624	4.638	.018	1.018	2.36
3. Quantity of exports of dressed softwood lumber except southern pine and the ratio of the price of these exports to the price of Douglas-fir lumber in the U.S. domestic market:					
Price ratio not lagged	24.601	-38.245	-.232	17.26[1/]	1.97
Price ratio lagged	24.501	-38.193	-.232	17.23[1/]	1.97
4. Quantity of exports of rough softwood lumber except southern pine and the ratio of the price of these exports to the price of Douglas-fir lumber in the U.S. domestic market:					
Price ratio not lagged	97.814	-22.515	-.007	.39	2.11
Price ratio lagged	97.296	29.529	.012	.69	1.86
5. Quantity of exports of rough softwood lumber except southern pine and exports from Alaska and the ratio of the price of exports of rough softwood lumber except southern pine to an index of the price of Douglas-fir in the U.S. domestic market:					
Price ratio not lagged	66.964	-8.112	-.001	.08	2.07
Price ratio lagged	58.985	-6.882	-.001	.06	2.19
6. Quantity of exports of softwood lumber except exports from Alaska and the ratio of the price of all exports of softwood lumber to the price of softwood lumber in the U.S. domestic market:					
Price ratio not lagged	47.185	29.616	.011	.63	2.31
Price ratio lagged	43.548	31.322	.013	.72	2.34
7. Quantity of exports of softwood lumber and the ratio of the price of these exports to an index of the price of softwood lumber in the U.S. domestic market:					
Price ratio not lagged	74.076	22.558	.004	.24	2.32
Price ratio lagged	67.787	25.485	.005	.31	2.36
8. Quantity of exports of softwood plywood and the ratio of the price of these exports to the price of softwood plywood in the U.S. domestic market:					
Price ratio not lagged	59.249	-80.749	-.098	6.21[1/]	1.73
Price ratio lagged	26.777	-8.911	-.001	.08	1.86

[1/] Significant at 5-percent level.

The lack of positive correlation between export volumes and relative prices may be due to the importance of other variables that determine export volumes, or it may be that a time period of one quarter is too long to identify association between the two data series. This would especially be the case if spot markets tended to determine prices. In spot markets, relative prices could change rapidly within a time period of one quarter.

Hypothesis 4: There is a positive relationship between the volume of exports and the volume of domestic production.

The hypothesis was tested for the relationships shown in table 6. All relationships were respecified and estimated with a lag of one quarter. There were significant, positive relationships for the export categories of dressed southern pine lumber, rough southern pine lumber, and total exports of softwood lumber except exports from Alaska (table 6). According to the conceptual framework discussed previously, a positive relationship between the volume of exports and the volume of domestic production would be consistent with any of the following conditions.

1. Domestic supply assumed not to shift. An increase (shift) in domestic demand would lead to increased domestic production. Excess supply would decrease (shift) and excess demand would have to increase (shift) in order for the volume of exports to increase.

Table 6—Results of tests of hypothesis 4, by product category

Product category	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Quantity of exports of dressed southern pine lumber and production of softwood lumber in the southern pine region:					
Production not lagged	-0.255	0.0053	0.091	5.68[1/]	1.91
Production lagged	3.494	-.0019	-.014	0.82	1.79
2. Quantity of exports of rough southern pine lumber and production of softwood lumber in the southern pine region:					
Production not lagged	-1.312	.0135	.198	14.06[1/]	2.22
Production lagged	-1.555	.0137	.195	13.78[1/]	2.16
3. Quantity of exports of dressed softwood lumber except southern pine and production of softwood lumber except production in the southern pine region and Alaska:					
Production not lagged	11.554	.0024	.011	.63	2.54
Production lagged	7.978	.0029	.011	.61	2.56
4. Quantity of exports of rough softwood lumber except southern pine and exports from Alaska and production of softwood lumber except production in the southern pine region and Alaska:					
Production not lagged	31.031	.0126	.033	1.93	2.27
Production lagged	31.792	.0125	.031	1.87	2.25
5. Quantity of exports of softwood lumber except exports from Alaska and production of softwood lumber except production in Alaska:					
Production not lagged	24.466	.0189	.108	6.89[1/]	2.38
Production lagged	6.088	.006	.189	13.26[1/]	2.65
6. Quantity of exports of softwood plywood and production of softwood plywood:					
Production not lagged	5.567	.1402	.0152	.88	1.84
Production lagged	3.102	.0156	.0235	1.37	1.97

[1/] Significant at 5-percent level.

2. Domestic demand and excess demand assumed not to shift. An increase (shift) in domestic supply would lead to increased domestic production. Excess supply would increase (shift), leading to increased volume of exports.

3. Products that are exported and consumed domestically are not homogeneous. An increase (shift) in domestic demand would lead to an increase in domestic production that would result in an increase in the volume of specialty items produced for the export market. The resulting increase (shift) in excess supply of specialty items would lead to an increase in the volume of exports.

4. A combination of shifts in domestic supply and demand and excess demand as well as differing product mixes for the two markets that would lead to a positive relationship between the volume of exports and the volume of domestic production.

Without further information about the behavior of shifters of domestic supply and demand and excess demand, it is not possible to attribute movements in production and exports to either the domestic or export market. If, as might be expected, the economies of countries of the Caribbean area and Central America tend to have economic cycles that closely follow those in the United States, shifts in excess demand may explain at least part of the association of exports of southern pine lumber and production of softwood lumber in the southern pine region.

The lack of significant association between exports of dressed lumber except southern pine and domestic production is consistent with the results of tests of hypothesis 1. Shifts in product mix in the export market during times of upturns in domestic markets may account for the lack of correlation between domestic production and the volume of exports. A similar rationale could be developed for the weak correlation between the quantity of exports of softwood plywood and domestic production of softwood plywood.

The results of analysis for hypothesis 2 suggested that shifts in excess demand were probably important in determining the price and volume of exports of rough lumber (category 4 in table 6). The lack of significant correlation between domestic production and export volume suggests that shifts in excess supply are also important determinants of price and volume or that shifts in excess demand are not highly correlated with shifts in domestic demand and/or supply.

For category 5 in table 6, there was no significant difference in the correlation coefficients with production lagged or unlagged. This is consistent with the view that information on price changes in the two markets is generally available and that producers respond quickly to developments in the two markets.

Hypothesis 5: There is a positive relationship between production in the United States and price in the export market.

The hypothesis was tested for the data series shown in table 7. All relationships were respecified and estimated with a lag of one quarter. All price series were converted to indexes (1967 = 100), and all price indexes were deflated by the U.S. wholesale price index for all commodities.

In the unlagged form, there was a significant, positive relationship between production in the United States and price in the export market with one exception: An index of prices in the export market for dressed softwood lumber except southern pine and production of softwood lumber except production in the southern pine region and Alaska (table 7). According to the conceptual framework discussed previously, a positive relationship between production in the United States and price in the export market would be consistent with any of the following conditions:

1. Domestic supply and excess demand assumed not to shift. An increase (shift) in domestic demand would decrease (shift) excess supply, leading to higher domestic production and higher prices in the export market.

Table 7—Results of tests of hypothesis 5, by product category and price series

Product category and price series	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Price of rough southern pine lumber in the export market and production of softwood lumber in the southern pine region:					
Production not lagged	0.1197	0.00044	0.236	17.6[1/]	2.03
Production lagged	.559	-.000166	-.048	2.88	1.51
2. Price of dressed southern pine lumber in the export market and production of softwood lumber in the southern pine region:					
Production not lagged	.0567	.0005839	.287	22.9[1/]	1.89
Production lagged	.5508	-.0001245	-.017	0.992	1.34
3. Price of rough softwood lumber except southern pine in the export market and production of softwood lumber except production in the southern pine region and Alaska:					
Production not lagged	.0649	.0001821	.369	33.38[1/]	2.5
Production lagged	.2384	-.0000247	-.007	.40	1.76
4. Price of dressed softwood lumber except southern pine in the export market and production of softwood lumber except production in the southern pine region and Alaska:					
Production not lagged	.6887	-.000063	-.049	2.9	2.22
Production lagged	.6951	-.0000619	-.047	2.81	2.20
5. Price of rough softwood lumber except southern pine in the export market and production of softwood lumber in the Douglas-fir region:					
Production not lagged	.0821	.0004288	.339	29.28[1/]	2.54
Production lagged	.2285	-.0000379	-.003	.155	1.79
6. Price of dressed softwood lumber except southern pine in the export market and production of softwood lumber in the Douglas-fir region:					
Production not lagged	.2937	.0002508	.092	5.80[1/]	2.32
Production lagged	.6452	-.0001266	-.033	1.92	2.22
7. Price of softwood lumber in the export market and production of softwood lumber except production in Alaska:					
Production not lagged	.0471	.0001435	.487	54.12[1/]	2.48
Production lagged	.2685	-.0000278	-.019	1.09	1.58
8. Price of softwood plywood in the export market and production of softwood plywood:					
Production not lagged	.2341	.000123	.087	5.41[1/]	1.52
Production lagged	.6806	-.0001131	-.108	6.89[1/]	1.53

[1/]Significant at 5-percent level.

2. Domestic demand and supply assumed not to shift. An increase (shift) in excess demand would increase domestic production and increase prices in the export market.

3. A combination of shifts in domestic supply and demand and excess demand that would result in a positive relationship between domestic production and price in the export market.

A positive relationship between the price of exports and domestic production of rough lumber is not inconsistent with the view that shifts in excess demand have been important in determining the price and volume of exports of these products: Shifts in excess supply may also be important, however. The positive relationship between the price of dressed southern pine lumber in the export market and production of softwood lumber in the southern pine region is consistent with a view that shifts in excess demand as well as shifts in excess supply are important determinants of price and volume in the export market.

There was a negative, though not significant, relationship between the price of dressed softwood lumber except southern pine and domestic production (category 4 in table 7). This is not inconsistent with the previously discussed view that shifts in product mix in the export market that occur during cycles in domestic markets may be important determinants of the price and volume of exports.

When production was lagged one quarter, there was a significant, negative relationship between the price of softwood plywood in the export market and domestic production (category 8 in table 7), but the relationship was positive and significant with production unlagged. A shift in product mix in the export market as domestic markets go through cycles would be consistent with a negative relationship between price and production. The results of the analysis of hypothesis 5 suggest that if this does occur for softwood plywood, it occurs with a lag.

Hypothesis 6: There is a positive relationship between the volume of exports and price in the domestic market.

The hypothesis was tested for the data series shown in table 8. All relationships were respecified and estimated with a lag of one quarter in the domestic price index (1967 = 100). All price indexes were deflated by the U. S. wholesale price index for all commodities.

In the unlagged form, there were significant, positive relationships for all categories of exports except softwood plywood (table 8). According to the conceptual framework discussed previously, a positive relationship between the volume of exports and price in the domestic market would be consistent with any of the following conditions:

1. Domestic supply assumed not to shift. An increase (shift) in domestic demand would increase price in the domestic market and decrease (shift) excess supply. Excess demand would have to increase (shift) for volume to increase in the export market.

2. Domestic demand assumed not to shift. A decrease (shift) in domestic supply would increase price in the domestic market and decrease (shift) excess supply. Excess demand would have to increase (shift) in order for the volume of exports to increase.

3. A combination of shifts in domestic supply and demand and excess demand that resulted in a positive relationship between price in the domestic market and volume in the export market.

For the significant relationships, the value of R^2 ranged from a low of .074 for the volume of exports of all softwood lumber except exports from Alaska and an index of prices for all softwood lumber in the U.S. domestic market to a high of .256 for the volume of exports of dressed softwood lumber except southern pine and an index of prices for Douglas-fir lumber in the U.S. domestic market. The general effect of lagging price in the domestic market by one quarter was to lower the value of R^2 and to lessen the degree of significance of the relationship.

Table 8—Results of tests of hypothesis 6, by product category and price series

Product category and price series	Components of equation A	Components of equation B	R^2	F	Durbin-Watson statistic
1. Quantity of exports of rough southern pine lumber and the price of southern pine lumber in the domestic market:					
Price not lagged	-2.51	23.661	0.222	16.25[1/]	2.25
Price lagged	7.805	-6.982	-.022	1.29	1.82
2. Quantity of exports of dressed southern pine lumber and the price of southern pine lumber in the domestic market:					
Price not lagged	-0.55	9.075	.108	6.9[1/]	1.87
Price lagged	4.402	-4.577	-.033	1.93	1.68
3. Quantity of exports of rough softwood lumber except southern pine and exports from Alaska and the price of Douglas-fir lumber in the domestic market:					
Price not lagged	16.646	92.339	.111	7.14[1/]	2.26
Price lagged	40.467	66.675	.097	6.11[1/]	1.93
4. Quantity of exports of dressed softwood lumber except southern pine and the price of Douglas-fir lumber in the domestic market:					
Price not lagged	-4.903	59.758	.256	19.58[1/]	1.94
Price lagged	3.750	48.407	.244	18.34[1/]	2.01
5. Quantity of exports of softwood lumber from Alaska and the price of softwood lumber in the domestic market:					
Price not lagged	28.424	138.494	.150	10.07[1/]	2.12
Price lagged	62.463	84.644	.074	4.58[1/]	1.88
6. Quantity of exports of softwood plywood and the price of softwood plywood in the domestic market:					
Price not lagged	24.219	-23.525	-.014	0.80	2.09
Price lagged	15.987	4.443	.001	.03	2.10

[1/] Significant at 5-percent level.

Conclusions

The significant, positive relationship between quantities of exports and prices in the domestic market shown in table 8 suggest that shifts in excess demand have been important determinants of prices and volumes in the export market.

The positive relationships between exports of dressed southern pine lumber (category 2), other dressed lumber (category 4), and corresponding domestic prices are not inconsistent with previous speculation that shifts in the product mix of exports may occur. For example, U.S. exporters may ship larger quantities of lower valued products in response to shifts in excess demand and be less willing to produce specialty items that are higher priced. By contrast, there may be less opportunity to shift product mixes for the categories of rough lumber. These categories are likely to contain certain products such as large timbers that are relatively more homogeneous than categories of dressed lumber.

The lack of a significant, positive relationship between exports of softwood plywood and domestic price is not inconsistent with the view that shifts in both product mix and excess supply may be important in determining the price and volume of exports of this commodity.

The tests of the 6 hypotheses indicate that shifts in both excess supply and excess demand have influenced the pattern of interactions between U.S. domestic and export markets in terms of volume and price. Shifts in excess supply have been important in determining the volumes and prices of dressed softwood lumber and softwood plywood. The volumes of exports of these commodities tended to decline when prices in export markets increased (hypothesis 2). Export volumes also declined when the price in the export market tended to increase relative to price in the domestic market (hypothesis 3). The volumes of exports tended to increase when price in the domestic market increased (hypothesis 6). Results of the test of hypothesis 1 are consistent with the view that changes in product mixes of exports of dressed lumber and plywood occur according to conditions in domestic markets. Results of tests of hypotheses 4 and 5 generally neither supported nor refuted shifts in excess supply as being factors in explaining changes in the price and volume of exports of dressed lumber and plywood.

Shifts in excess demand also influence the volume of exports of dressed lumber (hypotheses 5 and 6).

Shifts in excess demand have been important in determining prices and volumes for exports of rough softwood lumber. The quantity exported tended to increase when the export price increased (hypothesis 2), and the volume of exports tended to increase when the domestic price increased (hypothesis 6). Results of tests of hypotheses 1, 3, and 5 neither supported nor refuted excess demand as a determinant of shifts in price and volume in the export market. Shifts in excess supply may also influence prices and volumes in the export market for rough lumber (hypothesis 4).

Price changes in one market are reflected quickly in the other market, especially for rough lumber (hypothesis 1). The possible changes in product mixes in the export markets for dressed lumber and softwood plywood may tend to mask any association of price changes in the two markets for these products.

Implications for Foreign Trade

Trade Policy

This analysis has shown that shifts in both excess supply and excess demand have caused shifts in the volume and value of exports of softwood lumber and softwood plywood. Changes in supply and demand in the domestic market are probably reflected rapidly in the export market and vice versa.

Policies to make U.S. exports responsive to domestic market conditions would probably have to be confined to those affecting domestic supply and excess demand. Manipulation of U.S. domestic demand to make exports responsive to domestic market conditions probably would be unacceptable in the United States except for reasons of national security.

Policies to make domestic supply responsive to short-run market conditions would be difficult to implement. The possibility of restricting exports of softwood lumber during times of peak domestic demand have been discussed in the past, but general restrictions on the export of softwood lumber and plywood have never been implemented. Taxes on exports are illegal in the United States. The United States does have restrictions on the export of roundwood logs from various public lands in the West (Lindell 1978). These restrictions, however, are not designed to make exports responsive to domestic market conditions. The possibility of increasing total domestic supply so as to increase volumes in both domestic and export markets has been discussed in hearings (U.S. Senate Committee on Banking, Housing, and Urban Affairs 1973). This option becomes limited by the availability of processing capacity for both lumber and plywood.

Efforts to make excess demand responsive to U.S. domestic market conditions have been limited mainly to negotiations between Japan and the United States. The concern has been stability of markets for softwood logs and softwood lumber. These markets are discussed at meetings of the U.S./Japan Forest Products Committee. The Committee meets periodically to discuss supply and demand conditions for forest products as well as other matters affecting trade. There have been no formal agreements, however, to make U.S. exports responsive to supply and demand conditions in either of the two countries.

The lack of detail in available data would be especially important in trying to anticipate the effects of restrictions if exported products differed from products consumed domestically or if the product mix in the export market was not constant over time. For example, the available data do not provide the base needed to identify what types of products may be involved in the shifts in excess supplies of dressed lumber. Nor is information available to determine if products classed as rough lumber could meet the needs of domestic markets. For example, if exports were restricted, how much difference would it make for the prices of various types of timber products in the domestic market?

Supply and demand conditions in both domestic and export markets would have to be monitored for the purposes of trade policy formulation. For example, an increase in price in the export market may be caused by either a shift in excess supply, reflecting domestic market conditions, or a shift in excess demand, reflecting primarily market conditions in other countries. Further research to identify linkages of shifts in excess supply and excess demand to specific variables would facilitate formulation of alternative policies.

Export Promotion

Results of this analysis suggest that interactions between export and domestic markets differ for rough softwood lumber compared with dressed softwood lumber and plywood. For dressed lumber and plywood, shifts in excess supply probably underlie major movements in price and quantity in the export market. Shifts in excess demand are more important determinants or price and quantity of exported rough lumber.

Promotion of exports must work through an increase (shift) in excess demand and through an increase (shift) in excess supply. Constraints on domestic demand as a means to increase excess supply in the export market are generally not used in the United States. An increase (shift) in domestic supply would be necessary to increase (shift) excess supply.

Efforts to promote the export of softwood lumber and softwood plywood from the United States have consisted primarily of attempting to increase (shift) excess demand. These efforts have focused mainly on the promotion of the sale of dimension lumber and plywood of the grades and sizes used in the United States. Examples include the promotion of the "platform frame" construction technique in Japan and western Europe and efforts to reduce tariff and nontariff trade barriers to imports of lumber and plywood from the United States. These efforts have met with limited success.

Recently, representatives of Japanese and U.S. industry have entered into discussions as to how U.S. producers might produce and market lumber of the sizes and grades consumed in Japan. If successful, these efforts would have the effect of shifting U.S. excess supplies of these products to the Japanese market.

Fluctuations in excess supply due to shifts in domestic demand give rise to the charge of importing countries that U.S. producers are "in and out" of the export market depending on domestic market conditions. Being "in and out" of the export market, however, is consistent with the conceptual model of trade discussed previously. Traditional approaches to alleviate shifts in excess supply as well as shifts in excess demand include long-term contracts and variations on joint-venture operations which assure the price and/or volume of exports despite market conditions in both the importing and exporting countries. Results of this analysis suggest that spot markets rather than long-term contracts better characterize price formation in the export market.

Efforts to influence excess supply for the purpose of promoting exports have generally been limited to educating U.S. producers about export opportunities, especially when U.S. domestic markets are slow. The U.S. industry also favors the concept of export trading companies which would influence excess supply through making help available for financing and other aspects of maintaining a viable, sustained presence in export markets.

Fluctuations in excess supply and excess demand work against stable, long-term trade relationships of the type that seem necessary for U.S. producers to maintain export sales. Whether or not promotion programs should be directed at excess supply or excess demand depends on the effectiveness of alternatives. Further research is needed to provide a basis for judging the effectiveness of alternative promotion programs. Research is needed to identify the linkages among excess supply, excess demand, and specific variables that shift these relationships. For example, estimates of the elasticity of excess demand with respect to price and with respect to variables that shift excess demand would enable U.S. producers to anticipate cycles in markets. These estimates also would help producers judge the effectiveness of alternative programs that have the intent of increasing (shifting) excess demand.

Further Research

Admittedly, this study has been exploratory and should be considered as just the first step in analysis of the linkages of export and domestic markets. The lack of homogeneity of products and lack of data to delineate specific products, especially for softwood lumber, will probably always be a problem in trying to understand the behavior of the two markets. There is little reason to expect that the detail of available data will improve on the sizes and qualities of lumber that is exported or produced domestically. Additional research could be attempted in the area of linking variables that shift supply and demand in the domestic market to shifts in excess supply; linking shifts in variables that influence supplies and demands in major markets for U.S. products to shifts in excess demand; estimation of the elasticity of price and quantity of exports with respect to these shifters; and estimation of the elasticity of quantity with respect to price for excess supply and excess demand. Estimates of elasticity with respect to variables that shift excess supply and excess demand would better enable the anticipation of movements in markets that influence the success of promotion programs and trade policies. These estimates plus estimates of the elasticity of supply and demand with respect to price would also allow analysis of the potential effectiveness of alternative programs and policies that influence the volume and value of exports.

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Appendix A

The Data base for Volumes and Prices of Exports of Softwood Lumber and Plywood

Data for the volume and value of exports of softwood lumber and plywood originate with Export Declaration Forms. These forms may be filled out by anyone associated with the sales transaction. The completed form contains information on the type of commodity and its volume, value, and destination. Commodities are classed according to "Schedule E codes." The Schedule E codes for categories of softwood lumber and plywood used in this study are shown in Table 9. All categories of rough lumber except Schedule E 2482115 were combined for the purposes of this analysis. Rough lumber is defined as lumber just as it comes from the saw whether in the original sawed size or edged, resawn, crosscut, or trimmed to smaller sizes (U.S. Bureau of the Census 1977). All categories of dressed or worked lumber except Schedule E 2482215 were combined. Dressed lumber is defined as lumber which has been dressed or surfaced by planing on at least one edge or face. Worked lumber is defined as lumber which has been matched (provided with a tongue-and-grooved joint at the edges or ends), shiplapped (provided with a rabbeted or lapped joint at the edges), or patterned (shaped at the edges or on the faces to a patterned or molded form) on a matching machine, sticher, or molder (U.S. Bureau of the Census 1977). The three categories of softwood plywood were combined. Softwood plywood has been classified by species only since 1978.

Table 9—Schedule E codes for softwood lumber and plywood used in the analysis and volume shipped in 1979

Schedule E code	Description	Volume
		million board feet
Lumber:		
2482105	Spruce lumber, rough.	125.9
2482110	Pine lumber, eastern white and red, rough.	30.8
2482115	Pine lumber, southern yellow, longleaf, etc., rough.	140.1
2482120	Ponderosa pine lumber, rough.	29.7
2482125	Pine, NSPF,[1/] rough.	32.5
2482130	Douglas-fir lumber, rough, under 2 in.	32.1
2482135	Douglas-fir lumber, rough, 2 in. to not over 5 in.	212.7
2482140	Douglas-fir lumber, rough, 5 in. and over.	156.3
2482145	Fir lumber, NSPF,[1/] rough.	38.2
2482150	Hemlock lumber, rough.	378.7
2482155	Larch lumber, rough.	1.4
2482160	Western redcedar lumber, rough.	21.3
2482165	Cedar lumber, NSPF,[1/] rough.	12.7
2482170	Redwood lumber, rough.	21.2
2482175	Softwood lumber, NSPF,[1/] rough.	14.9
2482205	Spruce lumber, dressed or worked.	25.2
2482210	Pine lumber, eastern white and red, dressed or worked.	5.4
2482215	Pine lumber, southern yellow, longleaf, pitch, etc., dressed or worked.	55.5
2482220	Ponderosa pine lumber, dressed or worked.	71.9
2482225	Pine, NSPF,[1/] dressed or worked.	66.1
2482230	Douglas-fir lumber, dressed or worked.	104.4
2482235	Fir lumber, NSPF,[1/] dressed or worked.	19.3
2482240	Hemlock lumber, dressed or worked.	85
2482245	Larch lumber, dressed or worked.	1.2
2482250	Western redcedar lumber, dressed or worked.	11.5
2482255	Cedar lumber, NSPF,[1/] dressed or worked.	10.5
2482260	Redwood lumber, dressed or worked.	8.9
2482265	Softwood lumber, NSPF, dressed or worked.	5.9
		million square feet, 3/8-inch basis
Plywood:		
6345040	Plywood, with a face ply of Douglas-fir.	337.7
6345050	Plywood, with a face ply of southern yellow pine, short leaf pine, slash pine, etc.	32.1
6345060	Plywood, with a face ply of softwood, NSPF.[1/]	32

[1/] NSPF = not specifically provided for.

Source: U.S. Bureau of the Census, 1980. U.S. exports: Schedule E commodity by country. Rep. FT410, Dec. 1979. U.S. Gov. Print. Off., Washington, D.C.

Appendix B

As a base for use in analyzing interactions of domestic and export markets, the data have shortcomings. For example, lumber of different sizes and grades of the same species may be different products as far as end uses are concerned. The data are reported as of the date of receipt by the Department of Commerce rather than the date of actual shipment. In some cases, this may introduce a lag of several months between the actual date of shipment and the date reported by the Department of Commerce. For example, a portion of the volume actually shipped in January of a year may not be reported as being shipped until March or April of the year. Errors in reporting data may go undetected. For example, the person filling out the Export Declaration Form may inadvertently use an incorrect Schedule E code. Despite these problems, however, the data will likely continue to be the primary source for analysis of interactions between domestic and export markets.

Test for Seasonality

The problem of seasonality in data series has not received much attention in the forestry literature, in part because most analyses have used annual data, e.g., Adams and Haynes (1980). Seasonality in data series can be a problem for analyses in that a pattern of variation in data may be attributable to seasonal factors rather than factors proposed as explaining the variation in the data. For example, lumber production may decline every winter, along with the number of housing starts, because of seasonal factors. If the two data series are not corrected for seasonality, correlation of the series may give the impression of a relationship that is different from the one attributable to underlying supply and demand conditions.

There are no regularly published series of seasonally adjusted data for the major variables that describe conditions such as production and prices in the timber industries. The U.S. Department of Commerce publishes seasonally adjusted data series for many other variables in Business Conditions Digest (Bureau of Economic Analysis monthly). Perhaps the most widely used of these series in the timber industries is data on seasonally adjusted housing starts.

Adjustment of data for seasonality may be subjective or it may involve quantitative analysis. The method to be used depends on the end use of the data and the analytical skills available. In this study, seasonal adjustment factors were calculated for each quarter by the use of moving averages. For each data series, a four-quarter, centered moving average of the original series was calculated. The original data series was then divided by this adjusted data series to obtain ratios to the moving averages for each quarter of the period, 1965-1978. For each quarter, the ratios were averaged to obtain a seasonal adjustment factor.

Most data series would have a pattern that the average of quarterly ratios to a moving average would not be equal, indicating the possibility of a seasonal factor in the data. The observed pattern in the data may indeed be due to seasonal factors or it may be due to chance. A two-tailed F test was used to determine whether the observed differences in ratios of actual to seasonally adjusted data were significant or not. The value of F in each case was calculated as the ratio of the variation in the ratio between quarters to the variation in the ratio within quarters. The value of F was evaluated at the 5-percent level.

Significant seasonal patterns were found only for data series on lumber production. For these series, seasonal adjustment factors were used to adjust the original data series in an attempt to account for seasonality prior to analysis of interactions between the export and domestic markets.

Darr, David R. Interactions between domestic and export markets for softwood lumber and plywood: tests of six hypotheses. Res. Pap. PNW-293. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1981. 22 p.

Price formation in export markets and available data on export and domestic markets are discussed. The results of tests of several hypotheses about interactions between domestic and export markets are presented and interpreted from the standpoints of trade promotion and trade policy.

Keywords: Markets (external), markets (internal), market prices, trade policy, import/export (forest products), softwoods, plywood.

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